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Like traditional portfolios, electronic portfolios (e-portfolios) showcase work, demonstrate progress, and guide students' development and learning. Many courses in higher education also use e-portfolios as a basis for enhancing teacher-student and student-student interactions. With the array of learner-centric technologies increasing available, e-portfolios are becoming vital in managing and recording students' learning outcomes over time, providing opportunities for alternative assessment that can supplement or replace more traditional ways of determining what students can do in the classroom. Such alternative means of assessment can play a key role in accreditation reviews at program or institutional levels.

Because they can encourage future educators to examine their development formatively over time and react accordingly, e-portfolios also have great potential in the preservice preparation and evaluation of teachers. Many states have enacted legislation to improve teacher education, certification, and professional development. California Senate Bill 2042, for example, mandates the incorporation of preparation standards (Table 1) with specified instructional activities and assessments for teacher preparation programs. This directive for "standards-based instruction" employs standards to guide and evaluate the acquisition of skills and concepts necessary for effective teaching and learning. This process involves (a) content standards (what students should know and be able to do in academic subjects), (b) developmental benchmarks (indicators of what students should know and be able to do at a specific time in their schooling), and (c) learning evidence (artifacts of the knowledge and skills that students demonstrate in order to meet the benchmarks).

In order to comply with the mandated directive and simultaneously take advantage of the benefits of portfolios, we implemented an e-portfolio system in the Teacher Education program at the University of Southern California (USC), designed around a curriculum dedicated to improving urban schools. The core objectives of the initiative are to (a) provide an effective mechanism for ongoing reflective learning, (b) enable better coordination and feedback for instructors on student work, and (c) develop a culture of evidence for student learning and educational impact. The use of e-portfolios in this context goes beyond professional teacher preparation standards and provides a model for improving the overall quality of education from both an instructional and learning perspective.

Conceptual Design

Numerous studies have demonstrated the benefits of portfolios for teacher preparation and for addressing program accreditation standards (Exhibit 1). With these studies in mind, our primary design goal for the Teacher Education program at USC was to develop an integrated e-portfolio system that could interface with existing campus-supported technologies and function as a dynamic instructional and knowledge management system. Figure 1 illustrates our conceptual model that integrates Blackboard, USC's content management system (CMS), with a journal/portfolio database and personal showcase Web sites for students. The resulting integrated system addressed the program's e-portfolio objectives by providing

- teacher candidates with an on-demand historical record of their personal and professional development,
- instructors with invaluable insights into the processes and outcomes of instruction and training based on individual and aggregated reviews of student e-portfolio entries, and
- administrators with the capacity for ongoing program evaluation and assessment using the e-portfolio database.

When aligned properly with preparation standards, e-portfolios based on such a model have the built-in capability to function as a database-driven educational accountability system (Chatterji 2002).

System Design Considerations

Prior to getting a fix on instructional requirements and curriculum alignment, faculty in the Teacher Education program spent a great deal of time analyzing essential implementation issues for the e-portfolio system's survival and effectiveness (Exhibit 3). Because system start-up costs and scalability issues weigh heavily on system sustainability, we needed to design a technology-based model within the context of the existing support and resource infrastructures. Since Blackboard was already in use throughout the university, we adopted it as the course-specific element. The e-portfolio system is embedded within Blackboard and functions as the student-centered learning component. Students develop their e-portfolios by consolidating their work throughout each semester into the e-portfolio database and then selecting their best products to showcase on their e-portfolio Web sites.

Program Curriculum Alignment

Aligning preparation standards with instructional practices and evidence of students' learning over time requires an intensive analytic process. We expedited such analyses with the help of online database applications (Figure 2) containing Web forms (Figure 3) and on-demand query functions (Figures 4, 5, and 6). This system allowed instructors to input the following pertinent information:

- relevant standards,
- descriptions of learning activities,
- specifications of evidence of learning, and
- other relevant performance expectations or assessments.

Using this system, we created matrix reports that displayed information in a variety of data combinations by querying information that instructors submitted. Figure 7, for example, shows a matrix report resulting from a query of how two instructors in different courses addressed a common standard. This report reflects both the conceptual alignment of instruction and assessment within an individual course and students' progressive development across more advanced courses. While multiple instructors address a common standard, their approaches vary, depending on personal style and course content. The online database technology accommodates instructor variability, allowing faculty members to retain freedom in their own classrooms while ensuring that they also adequately address relevant standards.

To ensure proper integration of instructing, assessing, and monitoring of individual and program performances, we asked each course instructor to prespecify a minimum of two signature projects or assignments for student input into the e-portfolio database. These signature projects have become the assessment infrastructure that connects the 14 courses in the program. They also serve as the basis for periodic reviews of student progress via e-portfolios and facilitate the faculty's analysis of whether the curriculum adds up to more than the sum of its courses. By requiring all students to incorporate the projects in their showcase e-portfolios at the conclusion of each course as well as using them during program entry, student teaching, and exit interviews, the process has resulted in greater internal curriculum consistency and a richer continuity of developmental progression.

Implementing the Technology-Supported Instructional Model

Once their course syllabi and classroom instruction are aligned with professional standards, each instructor had clear expectations for student performance and anticipated products (Exhibit 2). We also developed a standardized online format for recording student outcomes and for querying the e-portfolio database. Conceptually and operationally, the e-portfolio system serves as a database-driven instructional management

tool, documenting candidates' knowledge, reflective processes, and professional development. The database query function also supports the provision of structured feedback and centralized administration of formative and summative assessments. These snapshots construct a historical record that enables effective future planning. Tancock and Ford (1996) have claimed that the ease with which individuals can replay and review data from electronic portfolios enhances reflection among preservice teachers and have further suggested that students who develop portfolios accept greater responsibility for their own learning. Such desired outcomes dictated the implementation of our e-portfolio design since the USC Teacher Education system focuses on learner-centered principles that encourage students to regulate their own learning and development. Figure 8 provides a visual conceptualization of how these considerations resulted in a showcase portfolio Web site.

The initial required three courses (EDUC 200: Introduction to the Teaching Profession, EDUC 204L: Sociological Foundations of Education, EDUC 205L: Child Development and Learning in Schools) in the Teacher Education program focus on the formation of basic technology skills as well as foundational, pedagogical, sociological, and human development concepts and theories. From the first course on, students maintain an e-portfolio that contains an array of appropriate evidence of mastery of critical content and skills as prespecified by the newly aligned course syllabi. At each of the four program review points, students present their e-portfolios for faculty review. Faculty teams use the reported evidence to determine whether the student has successfully met the professional standards for advancement in the program. The first formal review occurs at the conclusion of the above three courses. The second review occurs after the student has completed all of the general methods courses. Depending on adequate developmental progress, the student will be advanced to student teaching. A third review occurs at the conclusion of two semesters of student teaching and the completion of the advanced methods courses. The cumulative evidence from the three previous reviews is used to make a final recommendation to the state that the student be awarded a teaching credential.

Once students successfully complete the second review and are advanced to student teaching, they also use their e-portfolios to respond to more in-depth questions related to pedagogical strategies and theories as a means to self-assess their professional development. In student teaching and the concurrent content methods classes, the e-portfolio functions as the showcase for instructional planning projects. Throughout the program, students' e-portfolios contain sequential and organized examples of reflective journals and classroom projects as well as students' perceptions of their own professional development. The personal reflections and signature assignments that students submit to the database during coursework become key e-portfolio artifacts for verifying their mastery of professional standards.

Outcomes of the e-Portfolio Initiative

Perhaps the most important outcome of this initiative has been our realization that planning for expansion is crucial when designing systemic components, rather than relying on an auxiliary use of technology. Such planning is especially crucial when a total program curriculum revolves around the e-portfolio and a relational database. Each new semester of the program produces a new cohort as well as new demands for infrastructure (including components such as a server, dedicated-system administrator, and user labs) and classroom support and training that is both complete and cost-effective. Creating a reliable and scalable technology support component can help offset other challenges, such as new instructors or professorial apathy.

Our experience has also demonstrated that the primary educational advantage of a database-driven e-portfolio design is the opportunity it provides for faculty to evaluate records of student performance and assess candidate competency, retention, and learning transfer through contextual information. Similarly, such a design assists faculty in assessing the effectiveness of instruction. Combined with other content and process indicators, such a database-driven design can support a longitudinal account of performance and outcome characteristics by using candidates as its own control (Figure 9).

Another outcome was a collateral effect of making a systemic program change. While there was full faculty participation in curriculum redesign, creation of standards-based course syllabi, and implementation of a overarching e-portfolio system, some faculty were not prepared to deal with the fact that "technology is not a neutral tool, but has content and pedagogical biases" (Zhao et al. 2002). Student records cumulating in the e-portfolio database will ultimately reveal various teaching and learning bottlenecks that must be addressed. To that effect, the design team must be prepared to provide on-demand guidance in assisting instructors who want help in taking fuller advantage of the e-portfolio capabilities and also in avoiding becoming vulnerable to the results of ongoing data analyses.

Designating students as the operatives and course syllabi as the drivers of the system has stabilized the initiative at the classroom level. Using the gateway course to establish foundational technological skills for all entering students has relieved instructors from having to teach such skills in later courses. Rather than encouraging basic skills acquisition, instructors in later courses can now emphasize enriching and generalizing technological skills. This outcome has also comforted those instructors whose technological skills are not adequate to teach skills acquisition. Integrating computing instruction in all courses has also established a more natural progression for students' developing technological skills, therefore requiring very little in terms of remedial instruction. Standardized course syllabi, which faculty members negotiated during the redesign initiative, have specified all instructional and technological expectations for both instructors and students. As the system has evolved, such specifications have helped to make technology use transparent and seamless within classroom instruction. However, during actual implementation, students were sometimes concerned that they had two assignments—the technological use of the e-portfolios and the preparation of the content for which they were responsible. Although we have not eliminated this problem, restructuring lesson prompts and simplifying procedures for entering information into the e-portfolio system have helped to ameliorate it.

Additionally, we have made improvements to our e-portfolio database input form in subsequent terms (compare Figures 10 and 11) in order to standardize assignment categorical labels through the use of predefined drop-down menus. This standardization has enabled more convenient query and review of student records and has made streamlined reports of e-portfolio content more appealing to instructors. Moreover, by using instructor and student feedback, continuous calibration of the system to accommodate increasing numbers of students has become a crucial scalability factor. The expanded number of data records inputted into the database as new cohorts have started each year has impacted both system capacity and, more importantly, instructors' motivation to use and enhance the system. The initial e-portfolio system involved 45 students and 2 instructors in a gateway course during the Fall 2002 term; the initiative has now expanded to include over 300 students across 6 courses in the Teacher Education program, covering instruction from initial foundation coursework to advanced student teaching.

Conclusion

While "bottom-up" faculty collaboration facilitated the redesign of the curriculum and technology support system, it has been challenging to sustain faculty members' active interest in helping the e-portfolio system grow. We have stimulated greater faculty engagement by preparing reports using longitudinal queries of the database that focus on assessments and signature products from each successive course. These reports have demonstrated graphically the potential of the querying functionality. As the program has progressed, this strategy has motivated both students and faculty to use the system and has demonstrated the ease with which students' performance histories can be brought up for review and advisement. Moreover, the cumulative, longitudinal, and relational database supports a continuous evaluation model. The e-portfolio entries for all courses between each of the three formal reviews, culminating in the final credential recommendation review, constitutes the "assessment spine" of the continuous evaluation model.

As the database expands with the completion and addition of student cohorts, we will also have the data resources to exercise more fully the potential research and development capability of the system. Using a "design-based" research model (Design-Based Research Collective 2003), we will be able to make

quality-verified adjustments at the student, course, and program sequence levels. For example, the first author (Tran 2004) applied the model to examine the influence theory-based instructor prompting and feedback procedures have on student effort and performance quality. The “institutional cycle design” involves two treatments that were conducted in two consecutive semesters of the same course and can be expanded to include all 14 courses in the program.

In this initiative, we were able to use the mandated response to the new state credentialing criteria as leverage for both program redesign and implementation. Nonetheless, we found it very important to address the following four elements successfully: (a) make access to the system infrastructure seamless to both faculty and students; (b) make certain that both regular and adjunct faculty receive the training required to access the system infrastructure easily; (c) specify an obligatory, syllabi-mandated minimum, e-portfolio activity plan that all instructors understand and carry out; and (d) quickly create a scalable infrastructure that supports faculty in the redesign of their own pedagogical strategies and encourages them to use data available in the system to support their decisions.

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